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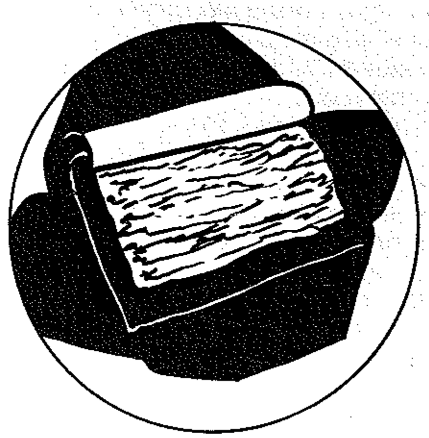


Convenience or Fabricated Foods: Spin Off of Military R&D

INTRODUCTION

As a result of demands on such disciplines as distribution, storage, palatability, etc., the Military feeding situation of today is likely to be a preview of what's in store for the American consumer tomorrow. Many of the technological developments of food research efforts for the Services have influenced food science and technology on the campus, in further government sponsorship and in industry. Below are described a limited number of processing techniques that we can reasonably expect to find in food and allied fields of the 1980's.

Complementing its development of innovative food processes designed to simplify and improve food logistics, the Military has also pioneered in R&D programs directed toward reducing the weight and volume and prolonging the storage life of packaged foods to provide greater efficiency for the transport, storage and distribution of combat rations. Realization of these objectives has resulted from research and development on two fronts: 1) reversible compression of dehydrated foods, and 2) flexible packaging systems for heat processed foods. Reversible compression provides for a decrease in volume commensurate with the 60 to 90% reduction in weight achieved by freeze-drying without altering the appearance, texture or other sensory properties of a food following its rehydration.

Reductions in volume ranging from 4- to 16-fold for fruits and vegetables and 3- to 4-fold for meat products have been achieved. As a result of these findings, procurement specifications were prepared for compressed peas, green beans, spinach and onions. Production test quantities were commercially produced and tested nationwide by the military services. They were highly accepted by the four Services, comparing favorably with the canned or the frozen product, and were recommended for inclusion in the current feeding system. Routine supply procurements of up to 40,000 dry kg have been made.

We are now getting ready to initiate our first major procurement of the "Individual Ready-to-Eat Meal" which will contain flexibly packaged, heat-processed, commercially sterile ready-to-eat foods which can be consumed with and without heating.

This procurement will climax extensive in-house and contractual R&D efforts of the Dept. of Defense to prove conclusively that a flexible package comprised of laminated aluminum foil and plastic materials equals the performance and reliability of the can as a package for heat-processed, shelf-stable foods.

The development of flexibly packaged foods to replace rigid, metal cans for heat-stabilized foods provides the soldier with a more convenient packaged food, somewhat lower in weight and bulk, and with significant economy of metal.

Before 1977, compressed dehydrated foods and flexibly packaged, heat-processed foods will both be available to civilian campers, sportsmen and special groups needing lightweight, shelf-stable, convenience foods and willing to pay a premium price. As a further degree of sophistication, compressed food bars are being developed which are suitable for direct consumption, as well as being hydratable to yield a familiar meal item such as beef stew, tuna salad and chocolate pudding. To avoid the harsh dryness of fully dehydrated foods, intermediate moisture food bars are under development which will closely simulate conventional foods. They are non-vulnerable to microbial attack, even if the integrity of their package has been lost. Such bars require no preparation.

Once these breakthroughs are accomplished, their energy-saving features will speak for themselves. Economies in packaging, shipping, weight and cube, and storage space both in the supply system and for the ultimate user will make compressed vegetables a "best buy" for the small hospital, convalescent home and other isolated food service establishments facing the problems of less frequent deliveries, and the resultant need for larger purchases and inventories.

As for the retortable pouch, a comparison of the total energy required to make four different 8-ounce packages showed that the pouch required the least energy — 1,934 BTU's. Each frozen food dish requires 45% more BTU's, each glass jar 64% more BTU's, and each can 84% more BTU's than the pouch (1). These costs do not address the additional savings in total energy in storage of the shelf-stable pouch vs a frozen dish.

New container shapes for thermally processed foods compatible with food service systems are currently under development. Retortable tray containers of half-steam table pan size, 298 mm × 238 mm by 51 cm deep (11-3/4 × 9-3/8 × 2 inches), are being developed of both metal and polymeric materials.

Holding the same volume and weight (2.98 kg) as the commercially available number 10 can (603 × 700) now used for institutional packs, this new package can be processed in one-half the time as the can. Thus, the quality of the initially produced products are superior to those of conventionally retorted products packed in the number 10 size can. Storage studies in progress show stability for one year at 21°C. and nine months at 38°C. with no deterioration in quality. The convenience aspects — ship and store, heat and serve in a single package — are sure to stimulate commercial availability within the next decade.

The convenience aspects of ready-to-eat tossed salads, and their potential for reducing not only labor requirements but also storage space and weight and volume during handling and distribution, have prompted the U.S. Army Natick Development Center to actively work on ways to increase the life of precut-tossed salads. While we have not pioneered this area, we have developed a new technique combining specific chemical pretreatment, proper packaging and storage temperature and attained salads acceptable after approximately four weeks of storage.

In addition, a technique combining the principles of intermediate moisture and dehydration was developed for the preservation of salad vegetables such as celery. Such a product is very stable after prolonged storage and rehydrates to a fresh-like texture.

Since 1953, the Dept. of Defense, through our Center, and the United States Energy Research and Development Administration (ERDA), has supported a comprehensive food preservation program based on the application of ionizing radiation in conjunction with protective packaging. Today, food irradiation programs are underway in 50 countries throughout the world.

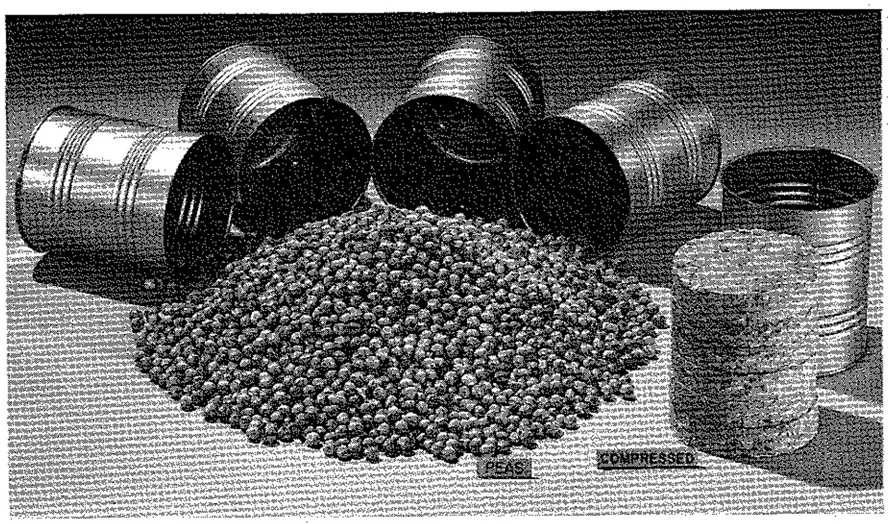
Irradiation lends itself to many applications in the area of food preservation. Irradiation can do things that cannot be done by other techniques.

Low dose irradiation (5,000 to 100,000 rads) reduces spoilage losses in potatoes and onions by inhibiting sprouting during storage. It also destroys insects that infest flour, grain and cereal; extends refrigerated shelf life of meat, poultry and fish; and delays ripening of some fruits (e.g., tomatoes, bananas).

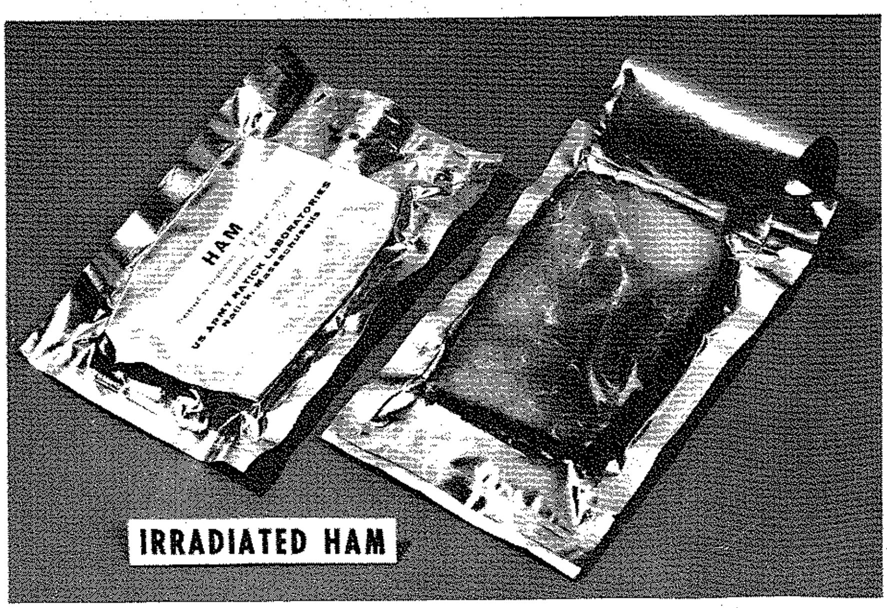
Moderate doses (100,000 to 500,000 rads) destroy specific pathogens, e.g., salmonellae, trichinae, tapeworms and liver flukes.

High dose irradiation (1 mega rad or more) can result in product shelf stable for years without refrigeration.

The main effort today in the United States is in the field of high-dose radiation sterilization (radappertization) of meats, poultry and selected seafood items as conducted primarily under the U.S.



Equivalent volumes (25 servings) of uncompressed and compressed freeze dried peas.



Irradiated ham—consumed on Apollo 17 and Apollo-Soyuz Space Flights.

Army's Food Irradiation Program. Since 1971, most of the activities have been concerned with the wholesomeness of radappertized enzyme inactivated beef in preparation for petitioning the Food and Drug Administration and the USDA for a regulation permitting the unlimited human consumption of irradiated beef.

The animal feeding testing using dogs, rats and mice will be completed in the spring of 1976. To date, there have been no indications from these studies that reflect adversely on the wholesomeness of radappertized beef. Other studies on radappertized pork, chicken and low nitrite-nitrate ham are being initiated in 1976.

Meat preservation by irradiation on a widespread commercial basis is still perhaps a decade in the future, although some specialized applications will come into use sooner. In my opinion, fully cooked ham will be the first radappertized meat item to appear on the U.S. market. Radappertized ham has already demonstrated its acceptability; consumed on the Apollo 17 flight, it was chosen again by all three U.S. Apollo-Soyuz astronauts. Other advantages of radappertized ham are:

1) Stability without refrigeration in a large range of container sizes and shapes — rigid and/or flexible containers.

2) Does not rely on nitrite for control of *Clostridium botulinum,* thus reducing the potential formation of nitrosamines which have been shown to be carcinogenic.

3) Cold sterilization results in higher packaged yields (i.e., no gelatin and less cook out).

Results of an Armed Forces food preference survey of 378 foods, administered to approximately 3,800 personnel from all four Military Services, have recently been published (2). This survey reflects how much the respondents liked each food (using a 9 point hedonic scale) and how often they wanted it served (preferred frequency score). Statistical analyses of food items within each food class identify foods of high and low preference. This study should be relevant to civilian populations of comparable age and especially those consuming institutionally prepared food.

The techniques and methodology employed in such studies and the research based on the studies should be applicable to any institutionally fed groups, e.g., school children and elderly people. Their use results in increased customer satisfaction and should, therefore, be useful in aiding the development of acceptable convenience or fabricated foods.

Cellulose is our most abundant organic material which can be used as a source of fuel, chemicals and food products. The net worldwide production of cellulose is estimated at 100 billion tons per year. This is approximately 150 pounds of cellulose per day for each of the earth's 3.9 billion people. Since cellulose is the only organic material that is annually replenishable in very large quantities, it should be exploited as a source of energy, food or chemicals. The utilization of this resource is greatly simplified if cellulose is first hydrolyzed to its monomer glucose — which can be used as a food consumable by man and animals, converted to chemicals, converted microbiologically into single-cell proteins or fermented to a fuel (ethanol).

It is estimated that from one ton of paper, one-half ton of sugar can be produced. The Pollution Abatement Division of our Food Sciences Laboratory is developing an enzymatic process for conversion of cellulose to glucose. The process is based on the use of the cellulase enzyme derived from a mutant of the fungus *Trichoderma viride* isolated and developed by the Natick Development Center. To produce the enzyme, the fungus is grown in a culture media, containing nutrients and cellulose. Following four days' growth the fungus is filtered out. The filtrate is the enzyme broth that is placed in the saccharification vessel. *Milled* cellulose is introduced into the enzyme solution, which is allowed to react with the cellulose to produce glucose sugar. The saccharification takes place at atmospheric pressure and at 50° C. The crude glucose syrup produced is filtered before further use.

The process can be applied to pure cellulose or waste cellulosic materials such as agricultural residue, bagasse or municipal trash.

This process, when fully developed, will have an enormous impact on the world's food, energy and ecology problems. This will be particularly true for developing countries. They will be able to utilize their waste products as a source of food and for animal feed.

In summary, I believe that spin off from R&D programs, sponsored by the Military, to attain shelf-stable convenience foods and simplify food logistics will have a significant impact on our civilian population during the forthcoming decade. Such programs combined with radiation and pollution abatement provide a technology base for reducing the food crises in the world of tomorrow.

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The Author

Herbert A. Hollender received his Ph.D. from the Univ. of Wisconsin before joining the staff of Purdue Univ.'s Dairy Dept. in 1948. He remained on the staff until 1955, when he then joined the Armed Forces Food and Container Institute in Chicago as Chief, Dairy, Fats and Oil Products Branch, Food Division. He became Director of the Division in 1961. When the Food and Container Institute relocated to Natick, MA, Hollender became Associate Director for Food of the new Food Laboratory. In 1974, the Food Engineering Laboratory was established at the U.S. Army Natick Development Center, with Dr. Hollender as Chief, Food Technology Division, with responsibility for all food product development.